AL-15-000-7784

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MAY - 5 2015

OFFICE OF
ADMINISTRATION
AND RESOURCES
MANAGEMENT

The Honorable John Boehner
Speaker of the House of
Representatives
Washington, D.C. 20515

Dear Mr. Speaker:

In accordance with the reporting requirements of the Federal Vacancies Reform Act of 1998 and the process established by the Government Accountability Office, I am forwarding the following information regarding a change to the status of Presidentially-appointed, Senate confirmed positions with the U.S. Environmental Protection Agency.

Position Title for Vacant Offices	**Date of Vacancy**
➢ Assistant Administrator for International and Tribal Affairs	07/07/13
➢ Deputy Administrator	08/10/14
➢ Assistant Administrator for Administration and Resources Management	08/31/14

Position Title for Vacancies with Nominees	**Date of Vacancy**
➢ Assistant Administrator for Research and Development	02/17/12
➢ Chief Financial Officer	03/31/13
➢ Assistant Administrator for Environmental Information	07/07/13
➢ Assistant Administrator for International and Tribal Affairs	07/07/13
➢ Assistant Administrator for Air and Radiation	07/19/13
➢ Deputy Administrator	08/10/14

Position Reporting Action on Nomination	**Date of Vacancy**
➢ Assistant Administrator for Water	02/12/11
➢ Assistant Administrator for Research and Development	02/17/12
➢ Chief Financial Officer	03/31/13
➢ Assistant Administrator for International and Tribal Affairs	07/07/13

➢ Assistant Administrator for Environmental Information	07/07/13
➢ Assistant Administrator for Air and Radiation	07/19/13

Position Reporting a Change	**Date of Vacancy**
➢ Assistant Administrator for Water	02/12/11
➢ Chief Financial Officer	03/31/13
➢ Deputy Administrator	08/10/14

The prescribed GAO form for reporting such events is enclosed. If you have any questions, please contact me or your staff may contact Christina Moody in the EPA's Office of Congressional and Intergovernmental Relations at moody.christina@epa.gov or at 202-564-0260.

Sincerely,

Susan A. Kantrowitz, Director
Office of Human Resources

Submission Under the Federal Vacancies Reform Act

Addressees

○ President of the United States Senate ● Speaker of the U.S. House of Representatives ○ Comptroller General of the United States

This Report Provides Notification of:

● Vacancy ● Designation of acting officer ○ Nomination ○ Action on nomination

○ Change in previously submitted reported information ● Discontinuation of service in acting role (date: 10/06/14)

Name of Department or Agency and Any Suborganization

Environmental Protection Agency

Vacancy Title	Date Vacancy Began
Deputy Administrator	08/10/14

Name of Acting Officer	Date Service Began	Authority for Acting Designation if Other Than Vacancies Act
Lisa Feldt	08/10/14	

Name of Nominee for Position	Date Nomination Submitted

Action on Nomination: ○ Confirmed ○ Rejected, withdrawn, returned — Date of Action:

Agency Contact

Name and Title

Karen Higginbotham, Director, Executive Resources Division

Contact's Address

1200 Pennsylvania Ave., NW, Washington, DC 20460

Contact's Phone Number	Contact's E-Mail Address
(202) 564-7287	higginbotham.karen@epa.gov

Submitted By

Name and Title	Telephone Number
Susan Kantrowitz, Director, Office of Human Resources	(202) 564-4606

Signature	Date
	MAR 4 2015

For Congressional Use Only

Committee of Jurisdiction

Date Received

For GAO Use Only

GAO Control Number

2/8/00

Submission Under the Federal Vacancies Reform Act

Addressees

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Name of Department or Agency and Any Suborganization

Environmental Protection Agency

Vacancy Title	Date Vacancy Began
Deputy Administrator	08/10/14

Name of Acting Officer	Date Service Began	Authority for Acting Designation if Other Than Vacancies Act
A. Stanley Meiburg	10/06/14	

Name of Nominee for Position	Date Nomination Submitted
A. Stanley Meiburg	01/27/15

Action on Nomination: ○ Confirmed ○ Rejected, withdrawn, returned — Date of Action

Agency Contact

Name and Title

Karen Higginbotham, Director, Executive Resources Division

Contact's Address

1200 Pennsylvania Ave., NW, Washington, DC 20460

Contact's Phone Number	Contact's E-Mail Address
(202) 564-7287	higginbotham.karen@epa.gov

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Name of Department or Agency and Any Suborganization

Environmental Protection Agency

Vacancy Title	Date Vacancy Began
Assistant Administrator for Air and Radiation	07/19/13

Name of Acting Officer	Date Service Began	Authority for Acting Designation if Other Than Vacancies Act
Janet McCabe	07/19/13	

Name of Nominee for Position	Date Nomination Submitted
Janet McCabe	01/07/14

Action on Nomination: ○ Confirmed ● Rejected, withdrawn, returned — Date of Action 12/17/14

Agency Contact

Name and Title

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Signature [signature] Date MAR 1 2015

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Name of Department or Agency and Any Suborganization

Environmental Protection Agency

Vacancy Title	Date Vacancy Began
Asst Admin for Administration and Resources Management	08/31/14

Name of Acting Officer	Date Service Began	Authority for Acting Designation if Other Than Vacancies Act
Nanci Gelb	08/31/14	

Name of Nominee for Position	Date Nomination Submitted

Action on Nomination: O Confirmed O Rejected, withdrawn, returned. Date of Action

Agency Contact

Name and Title

Karen Higginbotham, Director, Executive Resources Division

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Signature [signature] Date [illegible]

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Name of Department or Agency and Any Suborganization

Environmental Protection Agency

Vacancy Title	Date Vacancy Began
Chief Financial Officer	03/31/13

Name of Acting Officer	Date Service Began	Authority for Acting Designation if Other Than Vacancies Act
Maryann Froehlich	04/01/13	

Name of Nominee for Position	Date Nomination Submitted
Victoria Marie Baecher Wassmer	09/11/13

Action on Nomination: O Confirmed ●Rejected, withdrawn, returned Date of Action 01/03/14

Agency Contact

Name and Title

Karen Higginbotham, Director, Executive Resources Division

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Environmental Protection Agency

Vacancy Title	Date Vacancy Began
Chief Financial Officer	03/31/13

Name of Acting Officer	Date Service Began	Authority for Acting Designation if Other Than Vacancies Act
Maryann Froehlich	04/01/13	

Name of Nominee for Position	Date Nomination Submitted
Victoria Marie Baecher Wassmer	01/06/14

Action on Nomination: O Confirmed ● Rejected, withdrawn, returned | Date of Action 12/17/14

Agency Contact

Name and Title

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Name of Department or Agency and Any Suborganization

Environmental Protection Agency

Vacancy Title	Date Vacancy Began
Chief Financial Officer	03/31/13

Name of Acting Officer	Date Service Began	Authority for Acting Designation if Other Than Vacancies Act
Maryann Froehlich	04/01/13	

Name of Nominee for Position	Date Nomination Submitted
Victoria Marie Baecher Wassmer	01/06/14

Action on Nomination: ○ Confirmed ● Rejected, withdrawn, returned — Date of Action 12/17/14

Agency Contact

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Name of Department or Agency and Any Suborganization

Environmental Protection Agency

Vacancy Title	Date Vacancy Began
Chief Financial Officer	03/31/13

Name of Acting Officer	Date Service Began	Authority for Acting Designation if Other Than Vacancies Act
David Bloom	09/04/14	

Name of Nominee for Position	Date Nomination Submitted
Victoria Marie Baecher Wassmer	01/06/14

Action on Nomination: ○ Confirmed ● Rejected, withdrawn, returned — Date of Action 12/17/14

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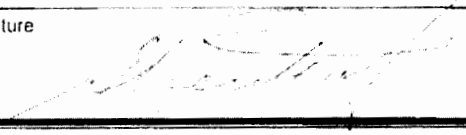
Signature  Date

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Name of Department or Agency and Any Suborganization

Environmental Protection Agency

Vacancy Title	Date Vacancy Began
Assistant Administrator for Environmental Information	07/07/13

Name of Acting Officer	Date Service Began	Authority for Acting Designation if Other Than Vacancies Act
Renee Wynn	07/07/13	

Name of Nominee for Position	Date Nomination Submitted
Ann Elizabeth Dunkin	01/30/14

Action on Nomination: O Confirmed ●Rejected, withdrawn, returned Date of Action 12/17/14

Agency Contact

Name and Title

Karen Higginbotham, Director, Executive Resources Division

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Name of Department or Agency and Any Suborganization

Environmental Protection Agency

Vacancy Title	Date Vacancy Began
Assistant Administrator for Environmental Information	07/07/13

Name of Acting Officer	Date Service Began	Authority for Acting Designation if Other Than Vacancies Act
Renee Wynn	07/07/13	

Name of Nominee for Position	Date Nomination Submitted
Ann Elizabeth Dunkin	02/12/15

Action on Nomination: ○ Confirmed ○ Rejected, withdrawn, returned | Date of Action

Agency Contact

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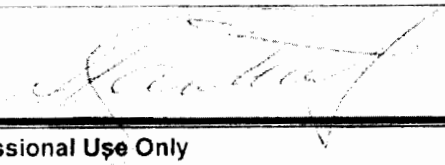
Signature  Date [illegible]

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O Change in previously submitted reported information ● Discontinuation of service in acting role (date: 04/15/14)

Name of Department or Agency and Any Suborganization

Environmental Protection Agency

Vacancy Title	Date Vacancy Began
Assistant Administrator for International and Tribal Affairs	07/07/13

Name of Acting Officer	Date Service Began	Authority for Acting Designation if Other Than Vacancies Act
Jane Nishida	10/22/13	

Name of Nominee for Position	Date Nomination Submitted
Jane Nishida	04/07/14

Action on Nomination: O Confirmed ●Rejected, withdrawn, returned | Date of Action 12/17/14

Agency Contact

Name and Title

Karen Higginbotham, Director, Executive Resources Division

Contact's Address

1200 Pennsylvania Ave., NW, Washington, DC 20460

Contact's Phone Number	Contact's E-Mail Address
(202) 564-7287	higginbotham.karen@epa.gov

Submitted By

Name and Title	Telephone Number
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Signature  Date

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Name of Department or Agency and Any Suborganization

Environmental Protection Agency

Vacancy Title	Date Vacancy Began
Assistant Administrator for International and Tribal Affairs	07/07/13

Name of Acting Officer	Date Service Began	Authority for Acting Designation if Other Than Vacancies Act

Name of Nominee for Position	Date Nomination Submitted
Jane Nishida	02/12/15

Action on Nomination: O Confirmed O Rejected, withdrawn, returned — Date of Action

Agency Contact

Name and Title

Karen Higginbotham, Director, Executive Resources Division

Contact's Address

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(202) 564-7287	higginbotham.karen@epa.gov

Submitted By

Name and Title	Telephone Number
Susan Kantrowitz, Director, Office of Human Resources	(202) 564-4606

Signature [signature] Date MAR 4 2015

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Submission Under the Federal Vacancies Reform Act

Addressees

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This Report Provides Notification of

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○ Change in previously submitted reported information ● Discontinuation of service in acting role (date 09/16/12)

Name of Department or Agency and Any Suborganization

Environmental Protection Agency

Vacancy Title	Date Vacancy Began
Assistant Administrator for Research and Development	02/17/12

Name of Acting Officer	Date Service Began	Authority for Acting Designation if Other Than Vacancies Act
Lek Kadeli	02/19/12	

Name of Nominee for Position	Date Nomination Submitted

Action on Nomination: ○ Confirmed ○ Rejected, withdrawn, returned — Date of Action

Agency Contact

Name and Title

Karen Higginbotham, Director, Executive Resources Division

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Name of Department or Agency and Any Suborganization

Environmental Protection Agency

Vacancy Title	Date Vacancy Began
Assistant Administrator for Research and Development	02/17/12

Name of Acting Officer	Date Service Began	Authority for Acting Designation if Other Than Vacancies Act
Lek Kadeli	11/12/13	

Name of Nominee for Position	Date Nomination Submitted
Thomas Burke	11/12/13

Action on Nomination: ○ Confirmed ● Rejected, withdrawn, returned Date of Action 01/03/14

Agency Contact

Name and Title

Karen Higginbotham, Director, Executive Resources Division

Contact's Address

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(202) 564-7287	higginbotham.karen@epa.gov

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Name of Department or Agency and Any Suborganization

Environmental Protection Agency

Vacancy Title	Date Vacancy Began
Assistant Administrator for Research and Development	02/17/12

Name of Acting Officer	Date Service Began	Authority for Acting Designation if Other Than Vacancies Act
Lek Kadeli	11/12/13	

Name of Nominee for Position	Date Nomination Submitted
Thomas Burke	01/06/14

Action on Nomination: O Confirmed ●Rejected, withdrawn, returned Date of Action 12/17/14

Agency Contact

Name and Title

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○ Change in previously submitted reported information ● Discontinuation of service in acting role (date 08/01/14)

Name of Department or Agency and Any Suborganization

Environmental Protection Agency

Vacancy Title	Date Vacancy Began
Assistant Administrator for Water	02/12/11

Name of Acting Officer	Date Service Began	Authority for Acting Designation if Other Than Vacancies Act
Nancy Stoner	02/13/11	

Name of Nominee for Position	Date Nomination Submitted
Kenneth Kopocis	03/13/13

Action on Nomination: ○ Confirmed ● Rejected, withdrawn, returned — Date of Action 01/03/14

Agency Contact

Name and Title

Karen Higginbotham, Director, Executive Resources Division

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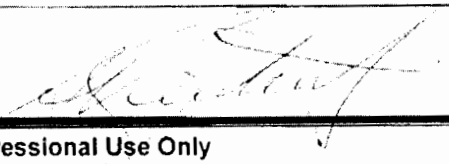
Signature  Date MAR 4 2014

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Name of Department or Agency and Any Suborganization

Environmental Protection Agency

Vacancy Title	Date Vacancy Began
Assistant Administrator for Water	02/12/11

Name of Acting Officer	Date Service Began	Authority for Acting Designation if Other Than Vacancies Act

Name of Nominee for Position	Date Nomination Submitted
Kenneth Kopocis	01/06/14

Action on Nomination: O Confirmed ●Rejected, withdrawn, returned Date of Action 12/17/14

Agency Contact

Name and Title

Karen Higginbotham, Director, Executive Resources Division

Contact's Address

1200 Pennsylvania Ave., NW, Washington, DC 20460

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Submitted By

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Susan Kantrowitz, Director, Office of Human Resources	(202) 564-4606

Signature  Date MAR 4 2015

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2/8/00

AL- 15-000-8333

JOHN BARRASSO M.D.
WYOMING
307 Dirksen Senate Office Building
Washington, DC 20510
202-224-6441

COMMITTEES
ENERGY AND NATURAL RESOURCES
ENVIRONMENT AND PUBLIC WORKS
FOREIGN RELATIONS
INDIAN AFFAIRS
[illegible]

United States Senate

April 10, 2015

Laura Vaught
Associate Administrator for Congressional and Intergovernmental Relations
Environmental Protection Agency
1200 Pennsylvania Avenue, NW, Room 3426 ARN
Washington, DC 20460-0001

Dear Ms. Vaught,

Enclosed is a copy of correspondence I have received from my constituent concerning presentations made by Exempt 6 / on September 8, 2014, and March 11, 2015, to EPA officials on the subject of fluoride exposure as it relates to IQ loss in children. I hope that you will carefully review this inquiry and provide a timely response to their questions.

Questions and correspondence can be directed to my Deputy Director of Correspondence, Joe Chaudoin, at 202-224-0810 or joe_chaudoin@barrasso.senate.gov.

Thank you for your prompt attention to this matter.

Sincerely,

John Barrasso

John Barrasso, M.D.
United States Senator

100 East B Street
Suite 2201
Casper, WY 82602
307-261-6413

2120 Capitol Avenue
Suite 2013
Cheyenne, WY 82001
307-772-2451

324 East Washington Avenue
Riverton, WY 82501
307-856-6642

1575 Dewar Drive
Suite 218
Rock Springs, WY 82901
307-362-5012

2 North Main Street
Suite 306
Sheridan, WY 82801
307-672-6456

Wyoming
Toll Free
1-866-235-9553
www.barrasso.senate.gov

Dear Senator Barrasso,

On September 8, 2014 and March 11, 2015 [redacted], and others representing me and other citizens concerned about recent publications in the peer reviewed scientific literature about IQ loss in children related to fluoride exposures made presentations to EPA officials on this subject.

I want you to direct the following question to EPA officials that I will name below:

"Please tell me what specific work, bevond 'reading and reviewing', your staff has done to analyze the information presented by [redacted] to your staff on September 8, 2014 and March 11, 2015 on IQ loss in children related to fluoride exposures.

Specifically, I want to know if your staff has applied EPA's Benchmark Dose methodology to the information made available by [redacted], and if so, what the results were.

If your staff has not done this work I want to know why, and when it will be done.

I want to know if any other risk assessment methodologies were used by your staff on this information, and if so, what the results were."

Please send this letter to the EPA Administrator Gina McCarthy; Acting Assistant Administrator for Water Ken Kapocis; Director of the Office of Ground Water and Drinking Water Peter Grevatt; Assistant Administrator for Research and Development Lek Kadeli, and in the Office of Water, Director of the Office of Science and Technology Betsy Southerland.

Thank you for your help in this matter that is very important to me.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MAY 2 1 2015

OFFICE OF WATER

The Honorable John Barrasso, M.D.
United States Senate
Washington, D.C. 20510

Dear Senator Barrasso:

Thank you for your recent letter to Laura Vaught, Associate Administrator for Congressional and Intergovernmental Relations, in which you forwarded an inquiry from your constituent regarding presentations made to the U.S. Environmental Protection Agency (EPA) by exempt on the topic of fluoride exposure and the potential for IQ loss in children. I am responding to your letter on behalf of Ms. Vaught by providing you with information on the EPA's activities related to the review of the EPA's fluoride drinking water regulation.

The National Primary Drinking Water Regulation for Fluoride includes an enforceable maximum contaminant level of 4.0 mg/L, which was set in 1986 to protect against crippling skeletal fluorosis. The regulation also includes a non-enforceable secondary maximum contaminant level for fluoride, which is set at 2.0 mg/L to protect against severe dental fluorosis.

The agency is in the process of reviewing the National Primary Drinking Water Regulation for Fluoride as part of its Six-Year Review of drinking water regulations, in accordance with Section 1412(b)(9) of the Safe Drinking Water Act. We are considering the information that exempt discussed, along with peer reviewed health effects studies and information on treatment, analytical methods and occurrence, to determine if a revision to the drinking water standard is appropriate.

We appreciate the information that exempt provided and the continued interest of concerned citizens regarding this topic. Again, thank you for your letter. If you have further questions, please contact me or your staff may contact Cathy Davis in the EPA's Office of Congressional and Intergovernmental Relations at Davis.CatherineM@epa.gov or 202-564-2703.

Sincerely,

Kenneth J. Kopocis

Kenneth J. Kopocis
Deputy Assistant Administrator

AL-15-000-8262

JOHN McCAIN
ARIZONA

CHAIRMAN, COMMITTEE ON
ARMED SERVICES
COMMITTEE ON HOMELAND SECURITY
AND GOVERNMENTAL AFFAIRS
COMMITTEE ON INDIAN AFFAIRS

United States Senate

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407 WEST CONGRESS STREET
SUITE 103
TUCSON, AZ 85701
(520) 670-6334

TELEPHONE FOR HEARING IMPAIRED
(602) 952-2170

April 17, 2015

Mr. Arvin Ganesan
Associate Administrator
Environmental Protection Agency
1200 Pennsylvania Avenue, NW Room 3246 ARN
Washington, DC 20460-0001

Dear Mr. Ganesan,

I wish to bring to your attention a matter concerning exempt6 who has encountered a problem.

Because the situation is under your jurisdiction, I am respectfully referring this matter to you for consideration. I feel that this issue would be better addressed by you and request that you respond directly to exempt6

Thank you.

Sincerely,

John McCain

John McCain
United States Senator

JM/xcf

exempt6

exempt6

Dear Senator John Mccain,

I voted for you and respect you tremendously. I'm writing this letter appealing to you for help, I'm a 55 year old mother and grandmother who up to this year was very healthy , I have since been diagnosed with stage 4 ovarian cancer that has spread to my colon , I'm not a picture of health, and now I have been experiencing severe breathing problems ,not connected with my cancer ,I'm writing to you from a emergency room computer waiting for my ride ,they find nothing wrong except shortness of breath and pains in my chest ,but I cant breath and the reason I'm writing you is because I believe that this all stems from the spraying coming from the unmarked planes above my daughters home , where I have gone to be cared for and to be near my grandchildren when I pass. I'm writing you because I lived in North Phoenix Arizona for 13 years .My dearest friend said those are Chemical Trails planes, they omit chemical emissions and leave those nasty steaks in the sky ,she has numerous video and pictures of these lines and designs the planes leave behind. I hear them over head and now I have start experiencing severe stuffy nose and labored breathing ,pains in my chest . I did notice them a lot in Phoenix where I used to live. But its gotten worse,I love this country I'm no threat I'm so proud to be an American citizen why are they spaying me , I am now am very aware of their presence and feel that this is the reason I cant breath , my daughter thinks I'm nuts and wants to put me in the crazy home ,thank goodness I'm sick and she wouldn't do that to me now , But my friend said that she believes me and wondered why they would do this to me ? I'm not a criminal , I'm not a enemy of this country why me , what did I do wrong for them to be doing this to me , I know it sounds so far fetched but I now notice these chem-trails in the sky and notice my symptom's getting worse when I'm exposed to them ? Please I'm appealing to you for help I have a nephew who works in homeland security and I was going to ask him if this was possible ? Please think of your kids grandmother and how much they love her, why cut my life short when I'm so sick anyway ,my father and brother in laws were all veterans who proudly served this country , why single me out and hurt me , my grand children are near me too , breathing this in , they are innocent precious lives and deserve a healthy life , my friend said leave it in God's hand no evil deed goes unpunished , but

I don't want to die before my time ,please I beg you look into this for me or if you cant help please find someone who can . Thank you and God Bless you and your family. God Bless America and our brave troops . Sincerely , exempt6

exempt6

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

APR 30 2015

exempt 6

Dear exempt 6

We are in receipt of the letter you addressed to Senator John McCain who forwarded your letter on April 17, 2015, to the United States Environmental Protection Agency's (EPA) San Francisco Regional Office. Senator McCain requested that we respond directly to your concerns regarding the dispersal of aerosols from aircraft in the atmosphere and the health issues you are confronting. We are sorry that you are facing these health issues and sincerely hope you seek out the medical attention and care to address your needs.

The EPA is not aware of any deliberate actions to release chemical or biological agents into the atmosphere. What you describe in your letter are referred to as condensation trails, or "contrails," which are line-shaped clouds composed of ice particles that are visible behind jet aircraft engines under certain atmospheric conditions.

Jet aircraft engines operating at high altitudes emit tiny combustion-related particles from the burning of jet fuel, and water vapor present in the ambient atmosphere reacts with these particles to form contrails. Contrails are about 99 percent frozen water vapor and less than 1 percent combustion-related particles. These contrails spread due to atmospheric turbulence and sometimes join with other contrails and expand into large, natural looking clouds that can cover large areas of the sky. Persistent contrails can last for hours while growing to several kilometers in width and 200 to 400 meters in height.

Aircraft emission standards for gas turbine engines that power civil aircraft have been in place for about 30 years. The EPA sets the emission standards for the engines, and the Federal Aviation Administration enforces the standards. Emission standards apply to essentially all commercial aircraft and address smoke, unburned hydrocarbons, carbon monoxide, and oxides of nitrogen (NOx) for the landing and takeoff cycle. For your reference, enclosed are documents entitled "Aircraft Contrails Factsheet" and "Contrails Facts." We trust that this information will be helpful in responding to your concerns.

Sincerely,

Mike Bandrowski, Chief
Air Toxics, Radiation and Indoor Air

Enclosures

Cc: Sen. John McCain

United States Environmental Protection Agency | Air and Radiation (6205J) | EPA430-F-00-005 September 2000 www.epa.gov

Aircraft Contrails Factsheet

Summary

This fact sheet describes the formation, occurrence, and effects of "condensation trails" or "contrails." It was developed by scientific and regulatory experts at the Environmental Protection Agency (EPA), the Federal Aviation Administration (FAA), the National Aeronautics and Space Administration (NASA), and the National Oceanic and Atmospheric Administration (NOAA) in response to public inquiries regarding aircraft contrails. Contrails are line-shaped clouds sometimes produced by aircraft engine exhaust, typically at aircraft cruise altitudes several miles above the Earth's surface. The combination of water vapor in aircraft engine exhaust and the low ambient temperatures that often exists at these high altitudes allows the formation of contrails. Contrails are composed primarily of water (in the form of ice crystals) and do not pose health risks to humans. They do affect the cloudiness of the Earth's atmosphere, however, and therefore might affect atmospheric temperature and climate. The basic processes of contrail formation described in this fact sheet apply to both civil and military aircraft.

What are contrails?

Contrails are line-shaped clouds or "condensation trails," composed of ice particles, that are visible behind jet aircraft engines, typically at cruise altitudes in the upper atmosphere[1]. Contrails have been a normal effect of jet aviation since its earliest days. Depending on the temperature and the amount of moisture in the air at the aircraft altitude, contrails evaporate quickly (if the humidity is low) or persist and grow (if the humidity is high). Jet engine exhaust provides only a small portion of the water that forms ice in persistent contrails. Persistent contrails are mainly composed of water naturally present along the aircraft flight path.

How are aircraft emissions linked to contrail formation?

Aircraft engines emit water vapor, carbon dioxide (CO_2), small amounts of nitrogen oxides (NO_x), hydrocarbons, carbon monoxide, sulfur gases, and soot and metal particles formed by the high-temperature combustion of jet fuel during flight. Of these emittants, only water vapor is necessary for contrail formation. Sulfur gases are also of potential interest because they lead to the formation of small particles. Particles suitable for water droplet formation are necessary for contrail formation. Initial contrail particles, however, can either be already present in the atmosphere or formed in the exhaust gas. All other engine emissions are considered nonessential to contrail formation.

[1] This fact sheet focuses on contrails produced by aircraft engine exhaust. However, the term "contrail" is also used to refer to the short trails sometimes briefly appearing over aircraft wings or engine propellers, especially under mild, humid conditions. These contrails consist entirely of atmospheric water that condenses as a result of local reductions in pressure due to the movement of the wing or propeller.

Figure 1. Contrails forming behind the engines of a Lufthansa Airbus A310-330 cruising at an altitude of 35,100 ft (10.7 km) as seen from research aircraft (Photo: German Aerospace Center (Deutsches Zentrum fur Luft- und Raumfahrt (DLR)), Oberpfaffenhofen, Germany.) Inset: Contrails forming behind the engines of a large commercial aircraft. Typically, contrails become visible within roughly a wingspan distance behind the aircraft. (Photo: Masako Imai, Cloud Castle/Photo Sky Japan.)

How do contrails form?

For a contrail to form, suitable conditions must occur immediately behind a jet engine in the expanding engine exhaust plume. A contrail will form if, as exhaust gases cool and mix with surrounding air, the humidity becomes high enough (or, equivalently, the air temperature becomes low enough) for liquid water condensation to occur. The level of humidity reached depends on the amount of water present in the surrounding air, the temperature of the surrounding air, and the amount of water and heat emitted in the exhaust. Atmospheric temperature and humidity at any given location undergo natural daily and seasonal variations and hence, are not always suitable for the formation of contrails.

If sufficient humidity occurs in the exhaust plume, water condenses on particles to form liquid droplets. As the exhaust air cools due to mixing with the cold local air, the newly formed droplets rapidly freeze and form ice particles that make up a contrail (See Figure 1). Thus, the surrounding atmosphere's conditions determine to a large extent whether or not a contrail will form after an aircraft's passage. Because the basic processes are very well understood, contrail formation for a given aircraft flight can be accurately predicted if atmospheric temperature and humidity conditions are known.

After the initial formation of ice, a contrail evolves in one of two ways, again depending on the surrounding atmosphere's humidity. If the humidity is low (below the conditions for ice condensation to occur), the contrail will be short-lived. Newly formed ice particles will quickly evaporate as exhaust gases are completely mixed into the surrounding atmosphere. The resulting line-shaped contrail will extend only a short distance behind the aircraft (See Figure 2).

If the humidity is high (greater than that needed for ice condensation to occur), the contrail will be persistent. Newly formed ice particles will continue to grow in size by taking water from the surrounding atmosphere. The resulting line-shaped contrail extends for large distances behind an aircraft (See Figures 2 and 3). Persistent contrails can last for hours while growing to several kilometers in width and 200 to 400 meters in height. Contrails spread because of air turbulence created by the passage of aircraft, differences in wind speed along the flight track, and possibly through effects of solar heating.

What are the ingredients of jet fuel, and are they important to contrail formation?

All jet fuel is a hydrocarbon mixture containing small amounts of impurities and additives. All aircraft jet fuel is analyzed for strict impurity limits before use. The hydrocarbon content of jet fuel produces water vapor as a by-product of combustion. Contrails would not form behind aircraft engines without the water vapor by-product present in exhaust.

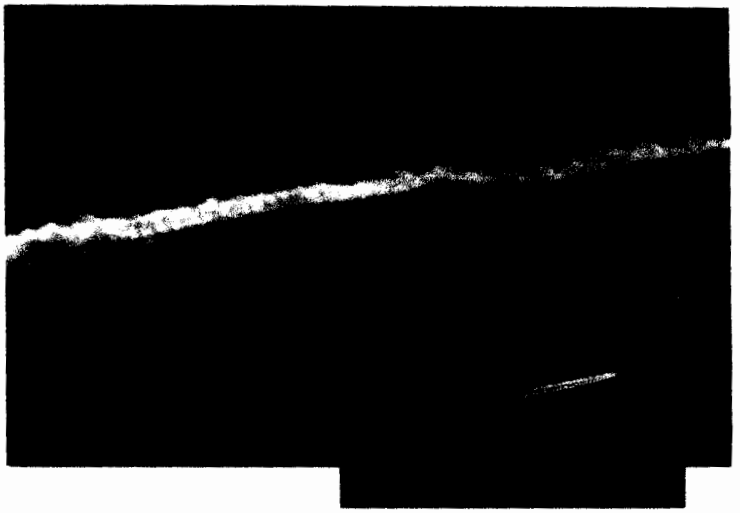

Figure 2. Photograph of two contrail types. The contrail extending across the image is an evolving persistent contrail. Shown just above it is a short-lived contrail. Short-lived contrails evaporate soon after being formed due to low atmospheric humidity conditions. The persistent contrail shown here was formed at a lower altitude where higher humidity was present. Inset: Another example of a short-lived contrail. (Photos: J. Holecek, NOAA Aeronomy Laboratory, Boulder, CO.)

Figure 3. Persistent contrails and contrails evolving and spreading into cirrus clouds. Here, the humidity of the atmosphere is high, and the contrail ice particles continue to grow by taking up water from the surrounding atmosphere. These contrails extend for large distances and may last for hours. On other days when atmospheric humidity is lower, the same aircraft passages might have left few or even no contrails. (Photo: L. Chang, Office of Atmospheric Programs, U.S. EPA.)

A common impurity in jet fuel is sulfur (~0.05% by weight), which contributes to the formation of small particles containing various sulfur species. These particles can serve as sites for water droplet growth in the exhaust and, if water droplets form, they might freeze to form ice particles that compose a contrail. Enough particles are present in the surrounding atmosphere, however, that particles from the engine are not required for contrail formation. There are no lead or ethylene dibromide additives in jet fuel. Additives currently used in jet fuels are all organic compounds that may also contain a small fraction of sulfur or nitrogen.

Why are persistent contrails of interest to scientists?

Persistent contrails are of interest to scientists because they increase the cloudiness of the atmosphere. The increase happens in two ways. First, persistent contrails are line-shaped clouds that would not have formed in the atmosphere without the passage of an aircraft. Secondly, persistent contrails often evolve and spread into extensive cirrus cloud cover that is indistinguishable from naturally occurring cloudiness (See Figure 3). At present, it is unknown how much of this more extensive cloudiness would have occurred without the passage of an aircraft. Not enough is known about how natural clouds form in the atmosphere to answer this question.

Changes in cloudiness are important because clouds help control the temperature of the Earth's atmosphere. Changes in cloudiness resulting from human activities are important because they might contribute to long-term changes in the Earth's climate. Many other human activities also have the potential of contributing to climate change. Our climate involves important parameters such as air temperature, weather patterns, and rainfall. Changes in climate may have important impacts on natural resources and human health. Contrails' possible climate effects are one component of aviation's expected overall climate effect. Another key component is carbon dioxide (CO_2) emissions from the combustion of jet fuel. Increases in CO_2 and other "greenhouse gases" are expected to warm the lower atmosphere and Earth's surface. Aviation's overall potential for influencing climate was recently assessed to be approximately 3.5 percent of the potential from all human activities (See Box 1).

Persistent line-shaped contrails are estimated to cover, on average, about 0.1 percent of the Earth's surface (Sausen et al., 1998; see Figure 4). The estimate uses:

- meteorological analysis of atmospheric humidity to specify the global cover of air masses that are sufficiently humid (low enough atmospheric temperature) for persistent contrails to form
- data from 1992 reported aircraft operations to specify when and where aircraft fly
- an estimated average for aircraft engine characteristics that affect contrail formation
- satellite images of certain regions of the Earth in which contrail cover can be accurately measured (See Figure 5)

The highest percentages of cover occur in regions with the highest volume of air traffic, namely over Europe and the United

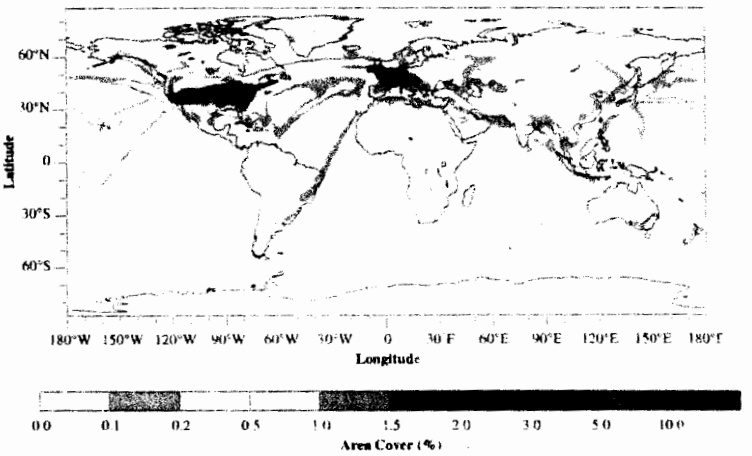

Figure 4. Estimated global persistent contrail coverage (in percent area cover) for the 1992 worldwide aviation fleet. The global mean cover is 0.1 percent. See text for description of how this estimate was made. (Reproduced with permission from Sausen et al., 1998, Figure 3, left panel.)

States (See Figure 4). This estimate of contrail cloudiness cover does not include extensive cirrus cloudiness that often evolves from persistent line-shaped contrails. Some evidence suggests that this additional cirrus cloudiness might actually exceed that of line-shaped cloudiness.

How is contrail coverage expected to change in the future?

Contrail cover is expected to change in the future if changes occur in key factors that affect contrail formation and evolution. These key factors include aircraft engine technologies that affect emissions and conditions in the exhaust plume; amounts and locations of air traffic; and background atmospheric humidity conditions. Changes in engine fuel efficiency, for example, might change the amount of heat and water emitted in the exhaust plume, thereby affecting the frequency and geographical cover of contrails. Changes in air traffic might also affect persistent contrail formation. It is currently estimated that regions of the atmosphere with sufficient humidity to support the formation of persistent contrails cover about 16 percent of the Earth's surface. If air traffic in these regions increases in the future, persistent line-shaped contrail

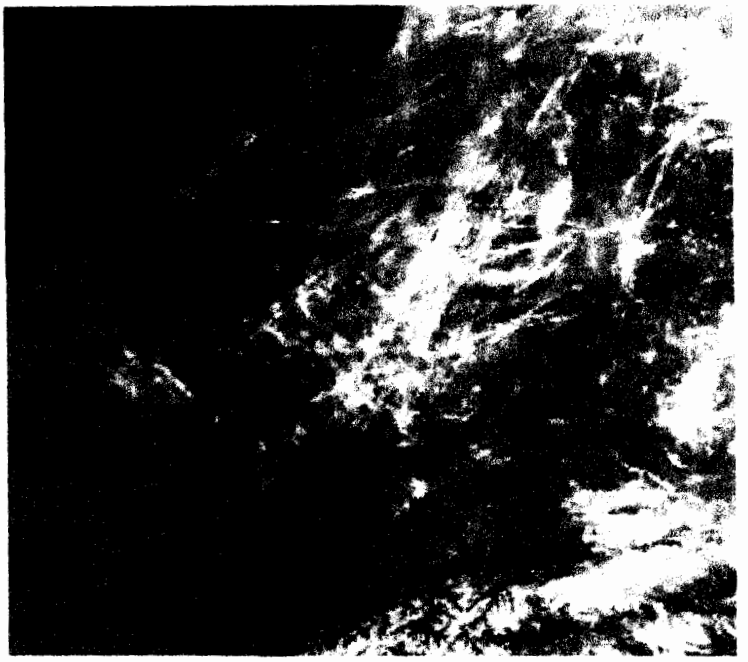

Figure 5. Satellite photograph showing an example of contrails covering central Europe on May 4, 1995. The average cover in a photograph is estimated by using a computer to recognize and measure individual contrails over geographical regions of known size. Photograph from the National Oceanic and Atmospheric Administration (NOAA)-12 AVHRR satellite and processed by DLR (adapted from Mannstein et al., 1999). (Reproduced with permission of DLR.)

BOX 1

Scientific Assessment of the Global Atmospheric Effects of Aviation

UNEP

WMO/OMM

The Intergovernmental Panel on Climate Change (IPCC) was established by the World Meteorological Organisation (WMO) and the United Nations Environment Programme (UNEP) in 1988 to assess the science, technology, and socioeconomic information needed to understand the risk of human-induced climate change. The 1999 IPCC report, "Aviation and the Global Atmosphere," (see References) describes current knowledge regarding aircraft effects on the global atmosphere. The report was compiled by more than 100 authors from 18 countries. Technical experts from the aviation industry, including airlines and airframe and engine manufacturers, worked with atmospheric scientists in creating this report.

The report considers all gases and particles emitted by aircraft into the upper atmosphere. It also examines the role these gases and particles play in modifying the atmosphere's chemical properties and initiating the formation of contrails and cirrus clouds. Chapter 3 of the IPCC report provides detailed information about contrail formation, occurrence, and persistence. The report also considers how potential changes in aircraft technology; air transport operations; and the institutional, regulatory, and economic framework might affect emissions in the future. It does not address the effects of engine emissions on local air quality near the surface or potential human health effects of engine emissions. The report notes that significant scientific uncertainty is associated with aviation's predicted influence on climate. A report summary is available from the IPCC Web site at <www.ipcc.ch>.

cover there will also increase. Overall, based on analysis of current meteorological data and on assumptions about future air traffic growth and technological advances, persistent contrail cover is expected to increase between now and the year 2050.

Are persistent contrails harmful to the public?

Persistent contrails pose no direct threat to public health. All contrails are line-shaped clouds composed of ice particles. These ice particles evaporate when local atmospheric conditions become dry enough (low enough relative humidity). The ice particles in contrails do not reach the Earth's surface because they fall slowly and conditions in the lower atmosphere cause ice particles to evaporate.

Contrail cloudiness might contribute to human-induced climate change. Climate change may have important impacts on public health and environmental protection.

Do authorities regulate aircraft emissions?

In the United States, some aspects of aviation emissions are regulated through the efforts of several government agencies. The U.S. Environmental Protection Agency (EPA), under the Clean Air Act (CAA) of 1970, has established commercial aircraft engine exhaust emissions standards for certain emittants associated with ground-level air pollution. Jet engine exhaust contains, among other emittants, oxides of nitrogen (NO_x) and hydrocarbons that contribute to ozone formation. Jet aircraft are one of many sources of these pollutants. Ozone is a prime ingredient of smog in and near cities and other areas of the country. While EPA establishes emissions standards for aircraft, the Federal Aviation Administration (FAA) of the U.S. Department of Transportation (DOT) administers and enforces these standards. This domestic framework for regulating aircraft engine emissions is more fully described in Box 2. Currently, there are no regulations addressing contrails and their atmospheric effects.

BOX 2

U.S. Environmental Regulatory Framework for Aircraft Engine Emissions

The Clean Air Act (CAA) directs the U.S. Environmental Protection Agency (EPA) to establish aircraft and aircraft engine emissions standards for any air pollutant that could reasonably endanger public health and welfare. In 1997, EPA aligned U.S. emissions standards (40 CFR Part 87) with engine emissions standards and recommended practices (SARPs) prescribed by the International Civil Aviation Organization (ICAO), a United Nations agency established in 1944 that develops SARPs using the technical support of member states and the aviation community. The United States is an active member of ICAO's Committee on Aviation Environmental Protection, which is responsible for further development of engine emissions standards. In establishing U.S. emissions standards, EPA must consult with the Department of Transportation (DOT) to ensure such regulations' effective dates permit the development of requisite technology, giving appropriate consideration to compliance cost. It must also consult with DOT concerning aircraft safety before promulgating emissions standards.

Under the CAA, DOT is responsible for enforcing standards established by EPA. DOT delegated enforcement responsibility to the Federal Aviation Administration (FAA). FAA has issued regulations administering and enforcing the emissions standards that apply to civil airplanes powered by gas turbine engines. FAA ensures compliance with these regulations by reviewing and approving certification test plans, procedures, test reports, and engine emissions certification levels. For more information on aircraft emissions or to access EPA's or FAA's aircraft regulations, visit the Aviation Emissions Website of EPA's Office of Transportation and Air Quality at <www.epa.gov/otaq/aviation.htm>.

For further information

Further scientific information about the effects of aircraft on the upper atmosphere can be found in the 1999 IPCC report, "Aviation and the Global Atmosphere" (see References). Information about aircraft and aircraft engine emissions regulations can be found at EPA's aviation emissions Web site, <www.epa.gov/otaq/aviation.htm>. Information about military aircraft and military space launch activities, and their atmospheric and environmental effects, can be found at <http://xre604.brooks.af.mil/safmiq/esoh_issues.htm>. For additional copies or further information on this fact sheet, contact the EPA Stratospheric Protection Hotline at 800 296-1996.

Note: Some images or photos in this fact sheet were provided courtesy of other institutions or parties and may be protected by copyright. Permissions regarding those photos or images need to be obtained from the indicated source.

References

Intergovernmental Panel on Climate Change (IPCC), 1999. Aviation and the Global Atmosphere. J.E. Penner, D.H. Lister, D.J. Griggs, D.J. Dokken, and M. McFarland, editors. Cambridge University Press. 373 pp.

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Mannstein, H., R. Meyer, and P. Wendling, 1999. Operational detection of contrails from NOAA-AVHRR data. *Int. J. Remote Sensing*, 20, 1641-1660.

EPA
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Environmental Protection Agency
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1200 Pennsylvania Avenue, NW.
Washington, DC 20460

Official Business
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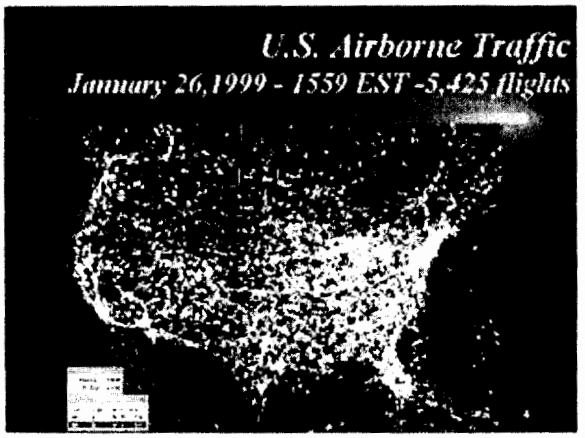
CONTRAILS FACTS

The Air Force operates many aircraft and space systems that are constantly interacting with the environment. Atmospheric interactions such as exhaust gases forming contrails, chaff and flares deployment that produce smoke, aerial pest or weed control spraying, or in-flight emergency fuel releases usually have very minor environmental impacts over a very limited geographical area. This site provides basic information and links about contrails, aircraft and space launch exhaust emissions, chaff and flares, aerial spraying, in-flight emergency procedures, and related topics.

Aircraft, engines, chaff, and flares can produce a variety of condensation patterns (or contrails), exhaust plumes, vapor trails, or smoke patterns. The exhaust emissions produced by aircraft and space launch vehicles can produce contrails that look very similar to clouds which can last for only a few seconds or as long as several hours. Vapor trails are formed only under certain atmospheric conditions and create a visible atmospheric wake similar to a boat propeller in water and usually dissipate very rapidly. Chaff and flares produce unique smoke patterns that are visibly different than a contrail but have the same color and appearance as a cloud but which also typically dissipates very quickly. Aerial spraying for pest or weed control and fire suppression are the only Air Force activities which involve aircraft intentionally spraying chemical compounds (insecticides, herbicides, fire retardants, oil dispersants). In the case of an in-flight emergency, jet fuel may be released to lighten the landing weight and minimize the risk of fire if the aircraft should crash.

Background

The US military has played a significant historical role in the development of aircraft and space launch vehicles, airspace management, environmental management, and public land management procedures. In the earliest years of aviation and rocketry and up through the late 1980s, the military owned and operated the majority of the United States aircraft and space launch fleets. Since the end of the 1991 Persian Gulf War, the USAF has been in a drawdown and restructuring mode. In 1990, there were approximately 9,059 aircraft in the Air Force inventory and approximately 6,126 aircraft in 2000. Of the approximately 6,228 aircraft in the USAF fleet in 1998, 4,447 were assigned to active duty Air Force installations and 1,781 were assigned to Guard and Reserve units, usually co-located at municipal airports. For a more detailed discussion on the changing nature of military and civilian aviation, see A Review Of Military Aviation And Space Issues at http://www.felsef.org/dec99.htm.



In the 1980s, commercial airline passenger service and satellite telecommunication growth resulted in an increase in civil aircraft and space booster fleets with numbers almost equivalent to the military (total of all services). Future projections for the next 15 years indicate that commercial aviation and space launch fleets will become larger than the military fleet.

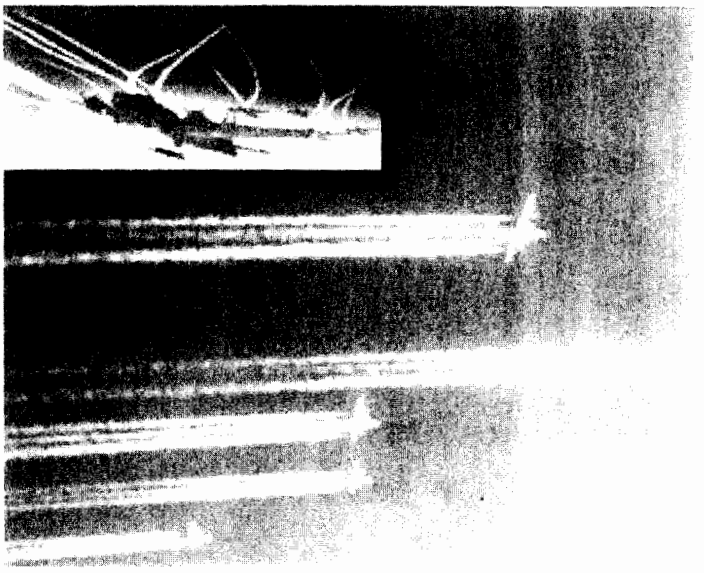
The civil aviation fleet is projected to grow from 12,281 aircraft in 1997 to 25,998 in 2017. The assumptions on growth rates and types of

aircraft are dependent on many changes in air traffic control, airspace management, and economic growth, but the general trend for civil aviation is increasing capacity by adding more frequent flights with smaller regional jets.

Aircraft fly along specific routes and corridors called the National Airspace System (NAS). The NAS is comprised of the air navigation routes and infrastructure across the United States that supports approximately 60,000 daily flights of commercial, general aviation, and military flights. The FAA is the lead federal agency charged with the operations and maintenance of the NAS. They manage over 5-million square miles of land routes and 23-million square miles of oceanic routes. The FAA must balance the safety and efficiency of the NAS on a daily basis. Many agencies and organizations are involved with the National Airspace System for a variety of purposes: civil air carriers, general aviation, military services, and research organizations. A typical snapshot of daily aircraft operations in the United States is shown below.

In the last ten years, there has been tremendous growth in the number of aircraft operated around the world. The majority of aircraft seen overhead are civilian flights, particularly near large cities. For a more detailed description of the NAS, see A Review Of Military Aviation And Space Issues: Aerospace And Airspace (Part II) at http://www.felsef.org/jan00.htm.

Condensation Trails ("contrails") from Aircraft Engine Exhaust



Contrails (short for "condensation trails") are line-shaped clouds sometimes produced by aircraft engine exhaust. The combination of high humidity and low temperatures that often exists at aircraft cruise altitudes allows the formation of contrails. Contrails are composed primarily of water (in the form of ice crystals) and do not pose health risks to humans. Contrails have been a normal effect of aviation since its earliest days. Depending on the temperature and the amount of moisture in the air at the aircraft altitude, contrails can either evaporate quickly or they can persist and grow. Engine exhaust produces only a small portion of the water that forms ice in persistent contrails. Persistent contrails are mainly composed of water naturally present along the aircraft flight path.

Aircraft engines emit water vapor, carbon dioxide (CO_2), small amounts of nitrogen oxides (NO_x), hydrocarbons, carbon monoxide, sulfur gases, and soot and metal particles formed by the high-temperature combustion of jet fuel during flight. Of these emittants, only water vapor is necessary for contrail formation. Sulfur gases are also of potential interest because they lead to the formation of small particles. Particles suitable for water droplet formation are necessary for contrail formation. Initial contrail particles, however, can either be already present in the atmosphere or formed in the exhaust gas. All other engine emissions are considered nonessential to contrail formation.

For a contrail to form, suitable conditions must occur immediately behind a jet engine in the expanding engine exhaust plume. A contrail will form if, as the exhaust gases cool and mix with surrounding air, the humidity becomes high enough (or, equivalently, the air temperature becomes low enough) for liquid water to condense on particles and form liquid droplets. If the local air is cold enough, these newly formed droplets then freeze and form ice particles that make up a contrail. Because the basic processes are very simple, contrail formation can be accurately predicted if atmospheric temperature and humidity conditions are known.

After the initial formation of ice, a contrail evolves in one of two ways. If the humidity is low, the contrail will be short-lived. Newly formed ice particles will quickly evaporate. The resulting contrail will extend only a short distance behind the aircraft. If the humidity is high, the contrail will be persistent. Newly formed ice particles will continue to grow in size by taking water from the surrounding atmosphere. The resulting line-shaped contrail extends for large distances behind an aircraft. Persistent contrails can last for hours while growing to several kilometers in width and 200 to 400 meters in height. Contrails spread because of air turbulence created by the passage of aircraft, differences in wind speed along the flight track, and possibly through effects of solar heating.

Thus, the surrounding atmosphere's conditions determine to a large extent whether or not a contrail will form after an aircraft's passage, and how it evolves. Other factors that influence contrail formation include engine fuel efficiency, which affects the amount of heat and water emitted in the exhaust plume.

Contrails become visible roughly about a wingspan distance behind the aircraft. Contrails can be formed by propeller or jet turbine powered aircraft. During WWII, large formations of bombers left strikingly remarkable contrail formations. Typical contrails are shown below.

The contrails formed by the exhaust at high altitude are typically white and very similar to cirrus clouds. As the exhaust gases expand and mix with the atmosphere, the contrail diffuses and spreads. It is very difficult to distinguish aged contrails from cirrus clouds. It is very difficult to distinguish aged contrails from cirrus clouds. At sunsets, these contrails can be visibly eye-catching and striking as they reflect the blue, yellow, and red spectrum of the reflected sunlight.

Persistent contrails are of interest to scientists because they affect the cloudiness of the atmosphere. Scientists in the United States, Europe, and elsewhere have studied contrail formation, occurrence, and persistence, and research efforts on these topics continue. Shown below is a photo taken from the research aircraft Falcon of the German Aerospace Center (Deutsches Zentrum fh r Luft- und Raumfahrt (DLR) at about flight level 33,300 feet of an Airbus A340 with contrails (left) and a Boeing 707 without contrails (right). This illustrates a scientific effort to evaluate the effects of different engine characteristics on contrail formation.

The Air Force uses a Boeing 707 airframe for the KC-135 refueling and E-3 AWACS aircraft. The KC-135 fleet is in the process of upgrading to newer engines which produce fewer emissions and noise.Scientific research on contrails was recently summarized by an international group of experts. This summary can be found in Chapter 3 of the report, "Aviation and the Global Atmosphere," published in 1999 by Cambridge University Press for the Intergovernmental Panel on Climate Change (IPCC). The report describes current knowledge regarding the effects of aircraft emissions on the global atmosphere. The full report is available from Cambridge University Press and a summary of this report is at www.ipcc.ch.

Wingtip Condensation Trails

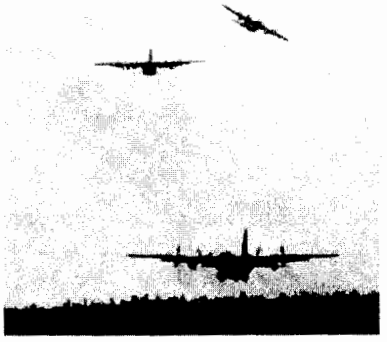
A different type of contrail or condensation trail is caused when a wing surface or winglet causes a cavitation of air in very humid conditions. This results in a unique vapor trail that is not formed due to exhaust gases. The next time you fly in a commercial aircraft through a rain cloud, look for the vapor trails that form over and around the wing. Typical fighter wingtip contrails are shown below.

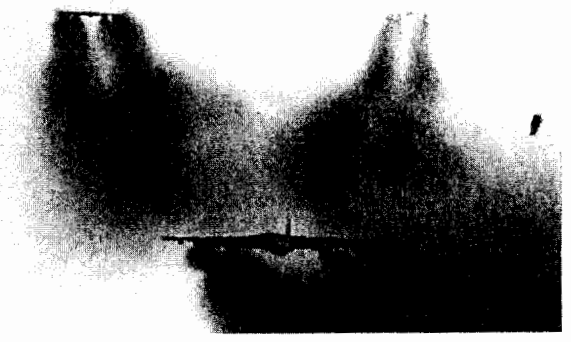
Exhaust Gases and Emissions

Often, military aircraft can be seen taking off with a black smoke appearing from the engines. This smoke is mainly soot particles, similar to diesel engines. Commercial aircraft also produce the same type of soot particles, but usually not to the same degree as military aircraft. This is for two reasons: the type of fuel and the type of engines.

Most military aircraft use JP-8 jet fuel which is a blend of commercial Jet Aviation Fuel -1 (or Jet A-1) with three extra additives. The additives are used to control ice formation, control biogrowth (molds and slimes), and inhibit corrosion. The military uses these additives because of the unique environments the military operates in, the type of self-sealing fuel tanks used, and the type of metals, plastics, and sealant used on military aircraft. Several specialized aircraft like the SR-71 and U-2 use different fuels than JP-8, but are developed from the same base stock. Fuels research is always ongoing. The newest fuel being brought into production is JP-8+100. Dubbed JP-8+100 because the additive package can increase the thermal stability of military fuel by 100 degrees Fahrenheit, the improved fuel helps prevent gums and deposits that can foul fuel lines.

Military engines are also designed with different performance characteristics than commercial aircraft. Military aircraft and engines also tend to be older and less efficient than commercial aircraft and produce more emissions. Engines are optimized for fuel consumption and power rates at a particular cruising altitude. At take-off, the engines are usually very inefficient and produce more emissions than when at the optimal cruising altitude. Older military aircraft like the B-52 and C-130 can leave a black smoke exhaust even at cruising altitude, while aircraft like the KC-135R with new engines produce an invisible exhaust plume. Typical pictures of aircraft exhaust emission are shown below.





Space launch vehicles and missiles produce a different type of exhaust than aircraft. The propulsion system on military rockets and missiles is usually made of solid rocket fuel. Missiles and rockets produce smoke plumes as a result of the solid fuel burning. The hot gases escaping from the motor can also create contrails, but the smoke and contrail combine to form a single exhaust plume. For more information on Air Force propulsion and fuels programs, see the Air Force Research Laboratory Propulsion Directorate at http://www.pr.afrl.af.mil/.

Chaff and Flares

Chaff and flares are defensive counter measures used on aircraft to confuse radar and heat seeking missiles. Chaff is used as a decoy for radar seeking missiles and is made of glass silicate fibers with an aluminum coating. The fibers are approximately 60% glass fiber and 40% aluminum by weight. The typical Air Force RR-188 chaff bundle contains about 150 g of chaff or about 5 million fibers. The fibers are 25 microns in diameter and typically 1 to 2 cm in length. In 1997, the Air Force used about 1.8 million bundles worldwide.

The amount of chaff released worldwide by all of the services is approximately 500 tons per year. Chaff falls to the earth at a settling velocity of approximately 30 cm per second. Atmospheric residence times range from 10 minutes for the majority of chaff released at 100 m to approximately 10 hours for chaff released at 10,000 feet. Chaff fibers experience little breakup before reaching the ground.

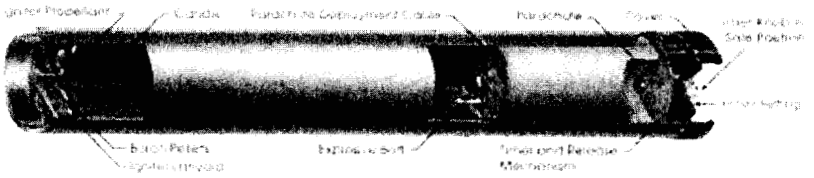
After the chaff is ejected from the aircraft and into the aircraft slipstream, the chaff packages burst open and the fibers scatter to form a radar-reflective cloud called a chaff corridor. Each chaff package is designed to simulate an aircraft. Several aircraft can create a chaff curtain, consisting of thousands of false targets, which confuse the radar guidance package on a missile so they are unable to locate the real targets within the chaff cloud.

Virtually all chaff fibers are 10-100 times larger than PM10 and PM2.5, the air particulates of concern for public health. The primary fiber size is usually too large to be inhaled by livestock, but if they are inhaled they do not penetrate far into the respiratory system and can be easily cleared out. The possible nutritional effects due to chaff ingestion and the risk is minimal to nil for both humans and livestock, considering the chemical composition of chaff (essentially identical to soil) and low chaff loading on the environment. Chaff decomposing in water has no adverse impacts on water chemistry or aquatic life.

Flares are of two types: decoy flares that protect aircraft from infrared missiles, and ground illumination flares. Decoy flares are typically made of magnesium that burns white-hot and are designed to defeat a missile's infrared (IR) tracking capability. The intense heat of the

pyrotechnic candle consumes the flare housing. Common aerial flares are: ALA-17/B, M-206, MJU-2, MJU-7 A/B, MJU-10/B, MJU-23/B, and RR-119.

Ground illumination flares, are designed to descend by parachute and provide up to 30 minutes of illumination of ground targets or activities. Typical flares are the LUU-1, LLU-5, and LLU-2B. A typical LLU-2B sectional is shown below.



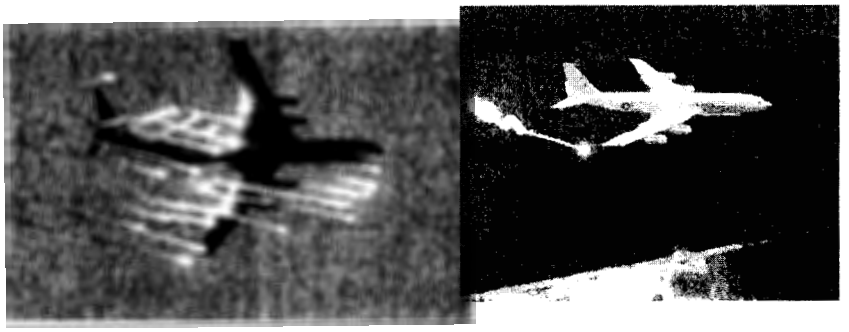
The ground illumination flare enhances a pilot's ability to see targets while using Night Vision Goggles (NVGs). Flares burn at uneven rates and fluctuate in brightness and are not used as frequently as in the past as the intense light interferes with the newer NVGs more sensitive sensors.

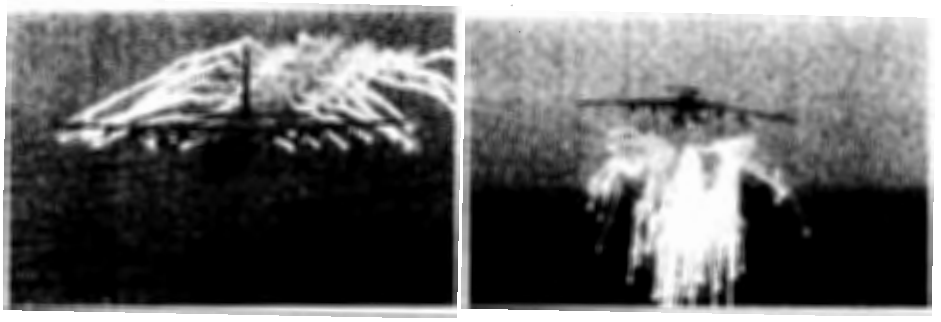
The composition and materials of flares used by the military are similar to standard flares used for aerial, highway and marine purposes. (Skyline). While unburned decoy flares falling from high altitude could be dangerous, flares are designed to burn up during the descent (even the aluminum casing is burned).

Chaff and flares are deployed on most Air Force aircraft from a common MJU-11 Chaff/Flare magazine that is integrated with the warning receiver (a device that alerts the aircraft a missile has locked onto the aircraft). The magazine has a capacity of 30 RR-188 or 30 M-206 flares.

A very thorough independent description of military systems, equipment, and capabilities is published by the American Federation of Scientists.

Typical chaff and flare deployments and patterns are shown in the following pictures.

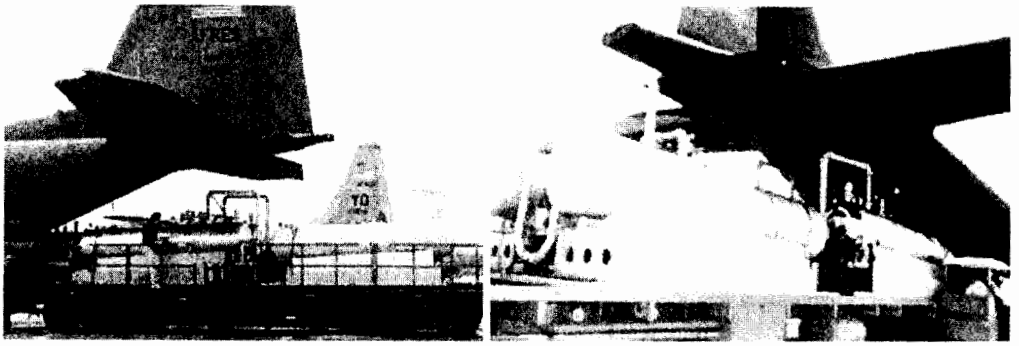




Aerial Spraying

There are some specific uses of commercial, private, and military aviation where chemicals are introduced in the atmosphere. The most common association of aerial chemical release is spraying for insects, either as crop dusting or mosquito prevention measures. These activities are typically performed at low altitude levels and produce a mist spray that drops to the earth's surface.

The only unit in the Air Force capable of aerial spray operations to control disease-carrying pests and insects is the AFRC's 910th Airlift Wing, Youngstown-Warren Air Reserve Station, Ohio (http://www.afrc.af.mil/units/910aw/default.htm). The aerial spray mission uses four specially configured C-130 Hercules shown below. Aerial spraying enables large parcels of land or water to be treated safely, quickly, accurately, and cheaply. This is the only fixed wing aerial-spray capability in the Department of Defense.



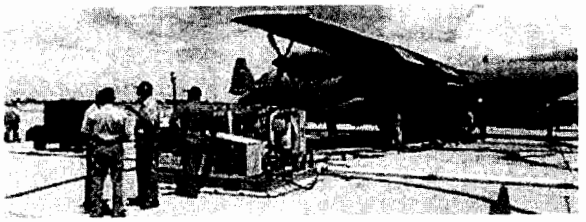
The mission started back in World War II, when legions of American GIs fell victim to malaria and dengue fever, diseases spread by mosquitoes. The mission was taken over from the active force in 1973. Although most of the unit's missions are initiated by the Department of Defense, its services are also requested by local, state and other federal agencies and coordinated the Center for Disease Control. The most common missions flown are for mosquito, sand flea and weed control. Several states have also requested support to combat grasshoppers and locusts. Aerial spray missions have been flown in Puerto Rico, Panama, Guam and the Azores.

The chemical compounds used for mosquito control are EPA controlled and the Air Force uses two primary brands; Dibrom and Anvil 10+10. Dibrom is manufactured by AMVAC Chemical Corporation and is classified as a Naled compound. Naled is an organophosphate insecticide that has been in use since 1959. It is used primarily for controlling adult mosquitoes but is also used on food and food crops, greenhouses and pet flea collars. Naled is applied using Ultra-Low Volume sprayers which dispense very fine aerosol droplets which kills the adult mosquito on contact. Naled is applies at a maximum aerial spray rate of 0.8 ounces of active ingredient per acre. Anvil 10+10 is manufactured by Clarke Mosquito Control Products, Inc and is a Sumithren, also known as a Synergized Synthetic Pyrethoid. Anvil 10+10 is applied using Ultra-Low Volume sprayers at a maximum aerial spray rate of 0.62 ounces of active ingredient per acre.

The chemical compounds used for herbicide weed control are EPA controlled and the Air Force uses Dupont Krovar I DF and Dow Agro Sciences Tordon K. Krovar I DF comes in granular form, is mixed with water and applied as an aerosol to control annual weeds at a rate of 4-6 pounds mixed with 40-100 gallons of water per acre. Tordon K is used as a herbicide to control broadleaf weeds, woody plants, and vines on non-crop areas such as forest planting sites, industrial manufacturing sites, rights-of-way such as electrical power lines, communications lines, pipelines, roadsides, railroads, and wildlife openings. Tordon K is applied at a maximum of 2 quarts per acre.

The 910th Airlift Wing has formed an Oil Dispersant Working Group, and is working with industry and government agencies to test aerial spray methods of controlling major offshore oil spills in coastal waters of the United States. The unit has six Modular Aerial Spray Systems (MASS) and four aircraft modified to accept the MAAS. Each MASS has a 2,000 gallon capacity and flow rate are set at 232 gallons per minute. The aircraft flies at 200 Knots Ground Speed at about 100 feet which covers a swath width of 100 feet for an average application rate of flow rate of 5 gallons per acre (variable 3-15 gallons per acre). Total spray-on time for 2,000 gallons lasts about 8 minutes and 30 seconds.

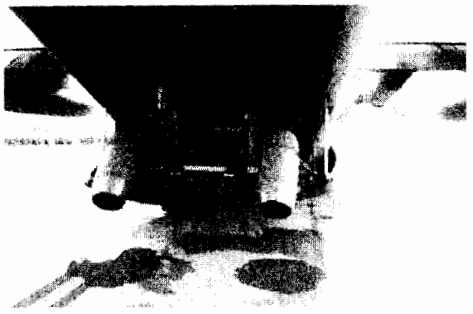
Photographs which show military aircraft with sprays coming from unusual locations on the aircraft are usually re-touched photos (a process that is easy to create using common computer programs).



Cloud Seeding and Fire Suppression

For a number of years commercial companies have been involved in cloud seeding and fire suppression measures. Cloud seeding requires the release of chemicals in the atmosphere in an effort to have water crystals attach themselves and become heavy enough to produce rain. The Air Force does not have a cloud seeding capability.

Fire suppression involves dumping chemicals onto a fire using cargo-type aircraft or helicopters. The 731st Airlift Squadron assigned to the 302nd Airlift Wing, Peterson Air Force Base, CO., is trained in the use of modular airborne fire fighting systems that help firefighting efforts of the U.S. Forest Service by dropping retardant chemicals directly onto fires. The unit's C-130s are loaded with a system designed to airdrop fire-retardant chemicals used in fighting forest fires and fertilizing the forest to generate quick regrowth. The 302nd AW has conducted firefighting response in Colorado, California, Oregon and Idaho.



U.S. forest fires generally occur in desolate, almost inaccessible geographical areas. The U.S. Forest Service turned to air power to help its ground fire fighting units quickly contain and suppress these fires. Over the years, the forest service has developed a highly effective air-attack organization and air tanker fleet to deal with the forest fire emergency.

In 1970, however, numerous catastrophic forest fires erupted in southern California, severely overloading the air tanker fleet's ability to cope with them all. This led to several U.S. Congressmen requesting the U.S. Air Force help the forest service by making military aircraft available as a back-up measure. This in turn led to the development of the Modular Airborne Fire Fighting System (MAFFS). The system is designed to quickly adapt military C-130 aircraft from a military role to a fire-suppression role.

Since 1974, the U.S. Air Force Reserve and Air National Guard units strategically located near high-incident forest fire areas have been equipped with these MAFFS units, and have sent selected aircrews to the aircrew training school for instruction in forest service air operations and procedures.

The MAFFS System is a modular, reusable airborne system for deploying water and fire retardant chemicals from aircraft in flight. It

consists of seven airborne modules and one ground air compressor module. The system can be loaded on a C-130 aircraft in two hours, and filled with retardant and compressed air in 15 to 20 minutes. The system is self-contained and requires no aircraft modifications. Each system weighs 10,500 pounds empty, and has a capacity of 2,700 gallons.

The entire load of retardant is discharged over a fire in 6 to 8 seconds.

Other AFRC aircraft shuttle Forest Service personnel and equipment to fire areas when the emergency requires a swift deployment to the fire line. This increased mobility allows more efficient use of Forest Service resources.

In-flight Emergency Fuel Release

Another common, but infrequent, procedure is the release, or venting, of fuel as a safety measure. If an in-flight emergency (IFE) is declared, a pilot will want to land the aircraft with as light a load as possible to prevent the possibility of damaging the aircraft and/or causing a fuel leak on landing. In order to lighten the fuel load a pilot can continue to fly until the fuel is burned or vent the fuel into the atmosphere. Fuel that is released, or vented, typically atomizes into a fine spray as it is released and typically evaporates before it reaches the ground. JP-8 jet fuel released at low altitudes appears as a fine mist and may not volatilize before reaching the ground surface. The release of fuel does not produce a contrail and appears more like a smoke pattern that dissipates quickly.

The "Chemtrail" Hoax

A hoax that has been around since 1996 accuses the Air Force of being involved in spraying the US population with mysterious substances and show various Air Force aircraft "releasing sprays" or generating unusual contrail patterns. Several authors cite an Air University research paper titled "Weather as a Force Multiplier: Owning the Weather in 2025" (http://www.au.af.mil/au/database/research/ay1996/acsc/96-025ag.htm) that suggests the Air Force is conducting weather modification experiments. The purpose of that paper was part of a thesis to outline a strategy for the use of a future weather modification system to achieve military objectives and it does not reflect current military policy, practice, or capability.

The Air Force's policy is to observe and forecast the weather. The Air Force is focused on observing and forecasting the weather so the information can be used to support military operations. The Air Force is not conducting any weather modification experiments or programs and has no plans to do so in the future.

The "Chemtrail" hoax has been investigated and refuted by many established and accredited universities, scientific organizations, and major media publications.

Claims and Facts

Claim: Long-lasting contrails are something new and they have abnormal characteristics.

Fact: Contrails can remain visible for very long periods of time with the lifetime a function of the temperature, humidity, winds, and aircraft exhaust characteristics. Contrails can form many shapes as they are dispersed by horizontal and vertical wind shear. Sunlight refracted or reflected from contrails can produce vibrant and eye-catching colors and patterns. Observation and scientific analysis of contrails and their duration date back to at least 1953.

Claim: Grid patterns of contrails in the sky are evidence of a systematic spraying operation.

Fact: The National Airspace System of the United States is orientated in an east-west and north-south grid with aircraft flying at designated 2000 foot increments of elevation. Contrails formed by aircraft may appear to form a grid as the winds disperse the contrails. More contrails are seen in recent years due to the growth in the civil aviation market. The FAA is responsible for the NAS and Air Force aircraft operate under the same rules and procedures as civilian aircraft when using the NAS.

Claim: There are reported outbreaks of illness after the appearance of "Chemtrails"

Fact: There is no such thing as a "Chemtrail". Contrails are safe and are a natural phenomenon. They pose no health hazard of any kind. If there are massive outbreaks of illnesses, your local health department should be able to tell you if it is an abnormal event. Local health departments generally network together when they start seeing problems. If there is a problem, the CDC will get involved.

Claim: Samples taken have shown the presence of the "DOD patented" bacteria pseudomonas fluorescens.

Fact: The bacteria claimed to be DOD developed and patented is actually a common, naturally occurring bacteria. The U.S. Patent Office (www.uspto.gov) lists 181 patents involving pseudomonas fluorescens, none of which are held by DOD.

Links to Related Sites

- FAA Office of Aviation Research – **http://research.faa.gov/aar/**
- FAA Office of Environment and Energy – **http://aee.hq.faa.gov/**
- DOT Bureau of Transportation Statistics – **http://www.bts.gov/**
- Center For Disease Control and Prevention – **http://www.cdc.gov/**
- EPA Office of Pesticide Programs – **http://www.epa.gov/pesticides**
- International Civil Aviation Organization – **http://www.icao.int/**
- Air Transport Association – **http://www.air-transport.org/**
- Aerospace Industries Association – **http://www.aia-aerospace.org/**
- Federation of American Scientists – **http://www.fas.org/index.html**
- General Electric Aircraft Engines – **http://www.geae.net/**
- Pratt and Whitney Aircraft Engines – **http://www.pratt-whitney.com/engines/**
- Rolls-Royce Aircraft Engines – **http://194.128.225.11/defence/milp001.htm**

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Pike, John, Aircraft Weapon Loads, Federation of American Scientists, 2000.

Aircraft and Contrails. EPA publication number EPA430-F-00-005. 6 pp EPA, 2000. (www.epa.gov/otaq/aviation.htm)

Layman's Library

Contrails - Contrails, or condensation trails, are "streaks of condensed water vapor created in the air by an airplane or rocket at high altitudes."(Webster's Dictionary). Contrails are the result of normal emissions of water vapor from jet engines. At high altitudes, water vapor condenses and turns into a visible cloud. Contrails form when hot humid air from jet engines mixes with the surrounding air in the atmosphere which is drier and colder. The mixing is a result of turbulence generated by the jet engine exhaust. The water vapor in the jet exhaust then condenses and forms a cloud. The rate at which contrails dissipate is entirely dependent upon weather conditions and altitude. If the atmosphere is near saturation, the contrail may exist for some time. Conversely, if the atmosphere is dry, the contrail will dissipate quickly.

Contrail Grid Patterns - Numerous contrails are usually over "air routes", or highways in the sky. Aircraft fly in all different directions at any time, and numerous contrails may seem to "crisscross". Although contrails may appear to cross, the trails can actually be from planes separated by significant altitude and time.

Chaff - Chaff are small bundles of aluminum coated fibers that create a large radar reflection. A radar seeking missile is unable to distinguish an aircraft from the chaff and loses the lock on the aircraft.

Chemtrails - Chemtrails is a term coined to suggest contrails are formed by something other than a natural process of engine exhaust hitting the cold air in the atmosphere.

Ethylene dibromide - Ethylene dibromide, or EDB, is a pesticide that was used commercially before being banned by the Environmental Protection Agency in 1983. During WW II, EDB was used as an additive in aviation gasoline to help stop lead in the aviation gasoline from plating out on valves. Jet fuels, including JP-8 have never contained EDB. Soil samples showing the presence of EDB are most likely residuals from previous use as a pesticide. Webster's dictionary definition of EDB: ": a colorless toxic liquid compound C2H4Br2 that is used chiefly as a fuel additive in leaded gasolines, that has been found to be strongly carcinogenic in laboratory

animals, and that was used formerly in the U.S. as an agricultural pesticide -- abbreviation EDB."

JP-8 Jet Fuel - JP-8 jet fuel consists of kerosene, a petroleum distillate fraction purchased to specification. The specification requires that the fuel producer meet a range of chemical and physical properties to ensure proper aircraft operation. Fuel additives are allowed, but are highly controlled. Additives include antioxidants, metal deactivators, corrosion inhibitors, fuel system icing inhibitor, and a static dissipater additive.

Rocket Exhaust - The exhaust plume generated by solid or liquid fueled rockets. Solid rocket motors are usually made of ammonium perchlorate and typically create light colored exhaust emissions. The exhaust is mainly carbon dioxide and water, but may also have high levels of hydrochloric acid formed, but which disperses rapidly. Liquid fuel rockets are generally kerosene and Liquid Oxygen (LOX) and produce an exhaust, which is darker and similar to aircraft exhaust. The exhaust is primarily carbon dioxide and water, but may contain nitrous oxides, sulfides, and soot particles.

Stratospheric Ozone - The ozone formed in the upper atmosphere through the interaction of the sun's energy and oxygen and which provides the natural shielding effect for the earth from UV rays. This ozone layer is susceptible to destruction by chlorinated compounds and is generally associated with the ozone hole over the Antarctic. Ozone in the lower atmosphere and ground level is generally a by-product of motor vehicle fuel combustion that forms NOx as a precursor which then forms ozone. This ozone is often seen as smog in most major cities.

Vapor Trails - The trail formed behind an aircraft as result of air flowing over a surface which creates a cavity in the air, similar to a boat propeller in water.